REMARKS

Claims 2-6 are pending in this application. By this Amendment, claim 2 is amended to overcome the 35 U.S.C. §112, first paragraph rejection. The amendment is supported by page 2, line 2 of the specification. No new matter is added by this Amendment.

I. Interview

The courtesies extended to the Applicants' representative by Examiner Zhu at the interview held November 18, 2008, are appreciated. The reasons presented at the interview as warranting favorable action are incorporated into the remarks below and constitute Applicants' record of the interview.

II. Rejection Under 35 U.S.C. §112, First Paragraph

Claim 2 was rejected under 35 U.S.C. §112, first paragraph, as allegedly failing to comply with the written description requirement. Applicants have amended claim 2 to recite preheating the charge and, when the temperature of the charge reaches 400 °C, introducing an active nitrogen carrier into the vacuum furnace chamber. The amendment to claim 2 is clearly supported by the specification at page 2, line 2 and page 2, line 18 of the specification.

Withdrawal of the rejection is respectfully requested.

III. Rejection Under 35 U.S.C. §103(a)

Claims 2-6 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,702,540 ("Kubota") in view of U.S. Patent No. 4,191,599 ("Stickels"). This rejection is respectfully traversed.

The Patent Office alleges that it would have been obvious to one of ordinary skill in the art to have selected a pressure range within the disclosed pressure range of Kubota "because Kubota discloses the same utility over the entire disclosed range." See Office Action, page 3.

Furthermore, the Patent Office alleges that Stickels discloses that nitrogen is a result-effective variable because it directly affects nitrogen content, nitrogen penetration depth, and resulting residual stress on the steel's surface. See Office Action, page 4. Applicants respectfully disagree.

A. First Declaration

Applicants previously submitted a Rule 132 Declaration ("First Declaration") to rebut the Patent Office's allegation regarding Stickels by providing evidence that the presently claimed method for under-pressure carburizing steel achieves unexpected results by restraining the austenite grain growth on the surface of the charge, while avoiding the formation of undesirable iron nitrides on the surface of the charge, when the active nitrogen carrier (e.g., ammonia) is (1) introduced into the vacuum furnace chamber during the preheating of the charge after the charge reaches 400°C (i.e., the lower limit) and (2) continuously introduced until the charge reaches the carburizing temperature, at which point the active nitrogen carrier is stopped and the carbon carrier introduction is begun (i.e., the upper limit).

However, the Patent Office found the First Declaration unconvincing, and alleged that the evidence provided regarding the temperature at which the nitrogen carrier in Experiments 2 and 4 was introduced (i.e., 20°C) and stopped (i.e., 400°C) did not establish the criticality of the recited temperature range because the temperature the nitrogen carrier was introduced at was too low. As such, the Patent Office recommended conducting an additional experiment where the nitrogen carrier was introduced at a temperature slightly lower than 400°C (e.g., 360-399°C) and stopped at 1000°C (i.e., the upper limit of the carburizing temperature).

B. Second Declaration

In accordance with the Patent Office's recommendation, attached hereto is a second Rule 132 Declaration ("Second Declaration"), that includes the Patent Office's suggested additional experiment (see Experiment 5 of the Second Declaration).

The Second Declaration demonstrates that the presently claimed method for under-pressure carburizing steel achieves unexpected results by restraining the austenite grain growth on the surface of the charge, while avoiding the formation of undesirable iron nitrides on the surface of the charge, when the active nitrogen carrier (e.g., ammonia) is (1) introduced into the vacuum furnace chamber during the preheating of the charge after the charge reaches 400°C (i.e., the lower limit) and (2) continuously introduced until the charge reaches the carburizing temperature, at which point the active nitrogen carrier is stopped and the carbon carrier introduction is begun (i.e., the upper limit).

1. The Lower Limit

As described in the Declaration, Experiments 1-5 were conducted on two different low carbon steel grade charges comprised of 16MnCr5 and 18CrNiMo7-6, respectively. Each of the low carbon steel grade charges were treated in a low-pressure vacuum furnace chamber at five different sets of process conditions labeled as Experiment 1, Experiment 2, Experiment 3, Experiment 4 and Experiment 5.

Experiment 1 consisted of conventional under-pressure carburizing without any introduction of ammonia gas during preheating of the charge to the carburizing temperature. Experiment 2 consisted of under-pressure carburizing with the nitrogen carrier in the temperature interval of 20°C - 400°C (i.e., starting below the lower limit). Experiment 3 consisted of under-pressure carburizing with the nitrogen carrier in the temperature interval of 400°C - 1000°C (i.e., representative of the claimed process). Experiment 4 consisted of

under-pressure carburizing with the nitrogen carrier in the temperature interval of 20°C - 1000°C (i.e., starting below the lower limit and continuing until the upper limit). Experiment 5 consisted of under-pressure carburizing with the nitrogen carrier in the temperature interval of 360°C - 1000°C (i.e., starting slightly below the lower limit and continuing until the upper limit). Experiment 5 is in accordance with the recommendation outlined by the Patent Office on page 5 of the August 15, 2008 Office Action.

As shown above in Table 2 of the Second Declaration and visually confirmed by Figures 1-2 of Second Declaration, the steel charges that were subjected to Experiment 3 (i.e., the claimed method) possessed the finest austenite mean grain diameter (10.3 μm for the 18CrNiMo7-6 charge and 15.6 μm for the 16MnCr5 charge). Furthermore, as shown above in Table 2, the process conditions of Experiment 5 (360°C - 1000°C) compared with the process conditions of Experiment 3 (400°C - 1000°C) significantly increased the austenite mean grain diameter by at least 23.3% for the 18CrNiMo7-6 charge and by at least 10.9% for the 16MnCr5 charge.

As such, the experimental results demonstrate that the presently claimed method for under-pressure carburizing a steel charge mixture by introducing an active nitrogen carrier into the vacuum furnace chamber during the preheating of the charge once the charge reaches 400°C unexpectedly restrained the austenite grain growth on the surface of the steel charge while avoiding the formation of undesirable iron nitrides that adversely affect the microstructure of the charge.

2. Upper Limit

As described in the Declaration, Experiments 6-8 were conducted to confirm that continuously introducing the nitrogen carrier (i.e., ammonia gas) from 400°C until the steel charge reaches the carburizing temperature (i.e., the upper limit), at which point the nitrogen carrier is stopped and the carbon carrier introduction is begun, unexpectedly restrains the

growth of austenite grains on the steel charge, while avoiding the formation of undesirable iron nitrides on the surface of the charge.

Experiment 6 consisted of "prenitriding", i.e., introducing the nitrogen carrier beginning at 400°C into a low-pressure vacuum furnace chamber containing a 18CrNiMo7-6 charge. The nitrogen carrier (i.e., ammonia gas) was continuously introduced into the vacuum furnace chamber for 70 minutes until the temperature of the steel charge was 750°C, a temperature less than the carburizing temperature (1000°C). At this point, the flow of the nitrogen carrier was stopped and the charge was heated to the carburizing temperature of 1000°C under vacuum. The carbon carrier was introduced once the charge reached 1000°C. The steel charge was then quenched and etched with Mi1Fe (Nital).

Experiment 7 was conducted under the exact same conditions as Experiment 6, except that the nitrogen carrier was continuously introduced into the vacuum furnace chamber for 120 minutes until the temperature of the steel charge reached the carburizing temperature of 1000°C. At this point, the flow of the nitrogen carrier was stopped and the introduction of the carbon carrier began. Experiment 7 corresponds to the process recited in the present claims.

Experiment 8 was conducted under the exact same conditions as Experiment 7, except that when the temperature of the steel charge reached the carburizing temperature of 1000°C, the introduction of the nitrogen carrier did not stop, but was introduced for an additional 10 minutes (130 minutes total).

As shown above in Table 4 of the Second Declaration and Figures 3-4 of the Second Declaration, introducing the nitrogen carrier under the process parameters of Experiment 6 (i.e., 400°C - 750°C for 70 minutes) compared to introducing the nitrogen carrier under the process parameters of Experiment 7 (i.e., 400°C - 1000°C for 120 minutes) resulted in only a 3.4 % increase in the retained austenite content charge. As such, comparing the results of Experiment 7 to Experiment 6 demonstrates that the nitrogen carrier may be dosed during the

entire preheating stage (i.e., until the charge reaches carburizing temperature and a carbon carrier is introduced) without significantly increasing (i.e., 3.4 %) the retained austenite content on the surface of the steel charge.

However, as shown above in Table 5 of the Second Declaration and Figures 3-4 of the Second Declaration, introducing the nitrogen carrier under the process parameters of Experiment 8 (i.e., 400°C - 1000°C for 130 minutes, or an additional 10 minutes after the charge reached the carburizing temperature) compared to the process parameters of Experiment 7 resulted in a 42.4% increase in the retained austenite content on the surface of the steel charge. As such, comparing the results of Experiments 7-8 demonstrates that extending the introduction of the nitrogen carrier after the steel charge reaches the carburizing temperature by only 10 minutes while introducing the carbon carrier, significantly increases (i.e., 42.4 %) the retained austenite content on the surface of the steel charge.

As such, the experimental results demonstrate that the presently claimed method for under-pressure carburizing a steel charge mixture by continuously introducing the nitrogen carrier from at least 400°C to until the charge reaches the carburizing temperature unexpectedly restrained the austenite grain growth on the surface of steel charge while avoiding the formation of undesirable iron nitrides that adversely affect the microstructure of the charge.

C. Conclusion

The unexpected results and criticality evidence provided in the Second Declaration demonstrates that the present claims recitation of (1) introducing the active nitrogen carrier into the vacuum furnace chamber during the preheating of the charge after the charge reaches 400°C and (2) continuously introducing the nitrogen carrier until the charge reaches the carburizing temperature, at which point the active nitrogen carrier is stopped and the carbon

carrier introduction is begun, cannot be considered to have been obvious from Kubota and Stickels.

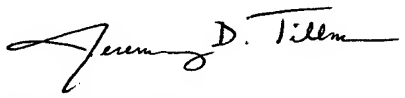
Withdrawal of this rejection under 35 U.S.C. §103(a) is respectfully requested.

IV. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 2-6 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



William P. Berridge
Registration No. 30,024

Jeremy D. Tillman
Registration No. 62,639

WPB:JDT/hs

Date: December 15, 2008

OLIFF & BERRIDGE, PLC
P.O. Box 320850
Alexandria, Virginia 22320-4850
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461